

extending to about 250 pages. The description of the fossil representatives is preceded by a sketch of the recent members of the group, illustrated by some excellent figures both of the habit and the anatomy. This method, which the author extends to all groups which have living representatives, is eminently suitable for a book which is intended for geologists as well as for those who have had a botanical training. The best known of the fossil Lycopods were trees; recently, however, we have learnt a good deal about herbaceous club-mosses which also flourished in Palæozoic times. These are fully described, and it is interesting to note how closely, in habit and reproductive methods, some of them approached the living genus *Selaginella*. On the other hand, we still have no proof of the early occurrence of *Lycopodium*, which on theoretical grounds is regarded as the more primitive type.

The great family of the *Lepidodendrea* is admirably treated, with equal regard to external features and internal structure. Some progress has now been made in correlating the two, and the results are sometimes a little surprising. Thus the well-marked anatomical species *Lepidodendron fuliginosum*, Williamson, is shown to correspond to at least three species based on external characters—a *Lepidophloios* and two species of *Lepidodendron* proper. Thus the two genera last-mentioned are indistinguishable, even specifically, by their anatomical characters, and it is very doubtful whether their claim to generic rank can be upheld.

Until quite recently we had but little knowledge of the structure of the well-known genus *Sigillaria*, but now, thanks to the work of Bertrand in France and of Kidston and Arber and Parkin in our own country, we have become acquainted with the anatomy of a number of species. The new evidence, together with the characters of the fructifications, has finally confirmed Williamson's view of the close affinity between *Sigillaria* and *Lepidodendron*, and of the cryptogamic nature of both alike. At the same time, facts have come to light which might once have been regarded as favouring Phanerogamic affinities, for in two genera of Palæozoic Lycopods organs closely analogous to true seeds have been discovered; in both cases the plants, one herbaceous, the other probably arborescent, are in all other respects typical members of the Lycopodiales. Their seed-like reproductive bodies are regarded by many palæobotanists as a striking instance of parallel development; the author, however, is inclined to see in them evidence of a genetic connection between the Palæozoic Lycopods and certain Conifers.

The second half of the volume is devoted to the Fern-like plants, and here the effect of recent discoveries makes itself felt in an even greater degree than elsewhere. As is well known, a large proportion of the Palæozoic Ferns, formerly so-called, are now under well-founded suspicion of not having been real Ferns at all, but seed-bearing plants of fern-like habit. In several cases this has been definitely proved, and in a majority of the plants in question all the available evidence points towards their spermatophytic

affinities. At the same time, the resemblance to Ferns, which for so long misled investigators, is by no means wholly fallacious, but, as shown by anatomical and other evidence, indicates a real relationship to the Fern-stock, while on the other hand the connection with the Cycad type of seed-plant is manifest. The practical difficulty is to distinguish between these "Ferns with seeds" and the true cryptogamic Ferns which no doubt really existed side by side with them; habit is no criterion, anatomy is only available in exceptional cases; even where the sporangia are present it is often impossible to say whether they were cryptogamic sporangia or pollen-sacs. The author takes a moderate and reasonable view of the difficult position; he recognises a considerable group of generalised Ferns, his *Cœnopterideæ* (the *Primofilices* of Mr. Arber), in which our knowledge of structure and of reproductive processes is sufficient to establish the Fern kinship; he is further inclined to admit a certain number of Palæozoic *Marattiales* (highly organised Ferns now only represented by a small tropical family), though here the evidence is a good deal more doubtful.

The *Pteridosperms*, as such, do not come into the present volume, but the last chapter is devoted to a number of genera of more or less uncertain position, most of which will no doubt prove to be seed-bearing plants, while a few may retain their traditional position among true Ferns. The clearly established types of *Pteridosperms* will be considered in vol. iii., which is to be devoted to seed-plants. This part of the work will be looked forward to with keen interest, for a number of questions of the utmost importance for the theory of evolution will then have to be considered.

The present volume, in its full and impartial treatment of habit and structure, of morphology and distribution, is beyond question the best handbook extant for the important fossil groups of which it treats. It is abundantly illustrated, and provided with an excellent index, and with a bibliography; the latter, taken in connection with that of vol. i., is singularly complete, so far as works of any importance are concerned.

Botanists are certain to appreciate Prof. Seward's work; we hope that it may receive equal recognition from geologists, who, even more than their botanical colleagues, stand in need of a modern text-book of fossil plants.

D. H. S.

THE COLLECTED WORKS OF HUYGENS.

Œuvres complètes de Christiaan Huygens. Publiées par la Société Hollandaise des Sciences. Tome douzième, Travaux de Mathématiques pures 1652-1656. Pp. vi+296. (La Haye: Martinus Nijhoff, 1910.)

THIS volume is the second one which contains reprints of published writings of Huygens, the ten first volumes having been devoted to his correspondence. During the years 1652 to 1656 Huygens had still to divide his attention between his scientific work and the study of law, but the extracts from his

note-books given in this volume show how little the law was able to fill his mind. In January, 1652, he began to occupy himself with various geometrical problems leading to equations of the second or third degree, of most of which he gave solutions in his "Illustrium quorundam Problematum Constructiones," which came out in 1654 as an appendix to his work on the quadrature of the circle. Both the rough work and the printed essay are reproduced in the present volume, and it is interesting to follow the stages by which he succeeded in submitting problems to algebraical analysis which Archimedes, Nicomedes, and other Greek mathematicians had treated by pure geometry.

The principal publication from this period of Huygens' life is his book on the quadrature of the circle, by which he took his place among the leading mathematicians of the day. It was a time when circle squarers flourished, several of them men of some distinction, such as Grégoire de St. Vincent, whose bulky work appeared in 1647 and called forth several polemical writings. Huygens entered the field in 1651 with his "Eξέραιος Cyclometriæ" (reprinted in T. XI. of the new edition), in which he showed the fallacy of St. Vincent's quadrature of the circle. In 1654 he brought out a larger work, "De Circuli Magnitudine Inventa." In this he developed further the use of the properties of the centre of gravity on the basis of the theorems he had published in 1651, and rigorously proved some propositions used by Snellius without proof, as well as a number of new theorems about sums of polygonal perimeters and various quantities, between which the length of the circumference of the circle is intermediate. Finally he calculated π by means of a 60-sided polygon within the limits of three units of the tenth decimal. The number of decimals is, of course, inferior to that previously attained by Van Ceulen and others, but the result was found without the appalling labours which these had gone through, and the investigation is valuable on account of the theorems proved by Huygens.

The lucidity and force of the arguments in the "Eξέραιος" had made its author hope that they had convinced Grégoire de St. Vincent of his mistakes. He exchanged a number of civil letters with St. Vincent, but the latter could never be induced to enter on a discussion of the matter, but always evaded it by saying that some day he would answer all his critics at the same time. But several of his pupils entered the lists for him, among whom was the Jesuit Ainscom, who in 1656 published what he imagined was a refutation of all the adversaries of his master, and did his best to convince people of the truth of the four methods of squaring the circle set forth by St. Vincent, but never put into practice by him. Huygens lost no time in replying; his "Epistola" to Ainscomb was published at the Hague in the same year. It forms the concluding portion of the present volume of his works, and in accordance with the praiseworthy rule of the editors of this most valuable edition of Huygens' works, the part of Ainscom's essay dealing with the attack of Huygens is also reprinted.

J. L. E. D.

A PRIMER ON COAL MINING.

First Steps in Coal Mining. For Use in Supplementary and Continuation Classes. By Alexander Forbes. Pp. viii + 320. (London, Glasgow, and Bombay: Blackie and Sons, Ltd., 1910.) Price 2s. 6d.

THE present adds one more to the already long list of primers on coal-mining that have been produced so freely of recent years, and unfortunately it cannot be said that it is sufficiently an improvement upon some of its predecessors to justify its publication. It is difficult to see to what class of student such a book as the present one can address itself, or which it can expect to benefit; if it is intended for the instruction of youths actually engaged in mining operations, such definitions as "the men engaged in the excavation of the material are termed *sinkers*," "the portion of the twenty-four hours during which each set works being called a *shift*," "the extreme end of the road . . . is called the *face*," &c., are surely superfluous, as these expressions must be familiar to every boy about a pit. If, on the other hand, the book is intended for those who have no personal knowledge of coal-mining, the amount of information afforded upon the majority of mining operations cannot possibly be sufficient to enlighten them; for instance, it is hopeless to expect that the subject of coal-cutting by machinery can be adequately taught in three pages; in the same way, only twenty pages are devoted to the whole subject of shaft-sinking, including all the special methods, entirely out of place though these are in an elementary book.

Just about one-third of the book has been devoted to an outline of geology, and this is the most, if not the only, satisfactory part of it. The remainder is made up of "scrappy" chapters on the various departments of mining, with some fragments of elementary chemistry and physics distributed amongst them. Not content with this wide range, the author has not hesitated to include even mine surveying, to which he devotes nearly four pages! Of what use he imagines that these can possibly be to anyone it is hard to conceive, even though he has inserted an illustration, without a word of description, of an old-fashioned theodolite, possibly with the object of giving an air of completeness to his index. Had the author contented himself with writing an elementary text-book of geology for the use of miners, he might probably have produced a work of greater use than the more ambitious effort now before us; at the same time, it cannot but be admitted that not even in the geological section has the author displayed the faintest evidence of originality in thought or treatment. This want of novelty throughout the book is shown very strikingly in the illustrations, every one of which appears to have been published before in other works. Their selection has, moreover, not always been a happy one, as witness the picture of the theodolite already referred to. For sheer futility it would be difficult to surpass some of the illustrations to the chemical section, such, for example, as Fig. 129, which represents water being poured out of a jug.

The very best thing that can be said of the book is that it is comparatively free from serious mistakes.